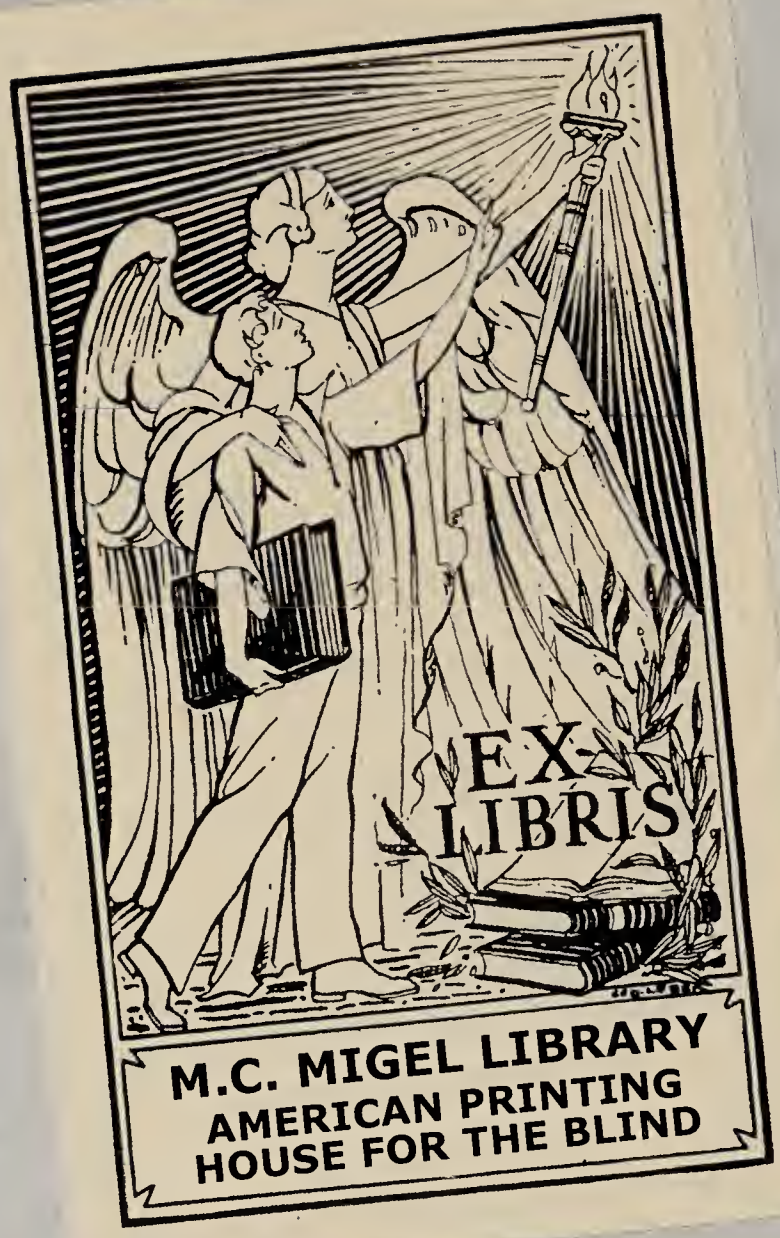
Washington University (St. Louis, Mo.)

Training of the Blind for Professional Computer Work

HV1711
W279


EX-
LIBRIS
M.C. MIGEL LIBRARY
AMERICAN PRINTING
HOUSE FOR THE BLIND

C.2

FINAL NARRATIVE REPORT

Training of the Blind for Professional Computer Work

RD-1485-S-67-C2

Project Director: Theodor D. Sterling, Professor of Computer Sciences

Associate Project Director: Seymour Pollack, Assistant Professor of Computer Sciences

Washington University, St. Louis, Missouri*

This investigation was supported, in part, by Research and Demonstration Grant #RD-1485-S-67-C2 from the Vocational Rehabilitation Administration, Department of Health, Education, and Welfare, Washington, D.C. 20201.

*(Project was started at the College of Medicine, University of Cincinnati, Cincinnati, Ohio)

(1967?)

HV1711
W279

Copy Two

Significant Findings for the Rehabilitation Worker

It was the purpose of this project to study and eliminate the many obstacles that stand between a blind person and the profession of computer-programmer. Some 42 blind individuals were accepted for training over a period of three years. Of these 40 finished and 39 are now employed.

Thus work as computer-programmer appears to be a comfortable field for blind individuals of all ages and abilities and with practically all educational backgrounds.

The major requirements for the field appears to be motivation and a reasonably normal intelligence as well as a strong desire to be independent. Actual educational background is probably of secondary importance as are various ability test scores.

Most individuals who are selected (on the basis of these criteria) tend to finish a program of training and subsequently become successfully employed.

The rehabilitation worker should be very much concerned with the ability of the training center to provide his client with adequate training. Training should not be limited to computer-programming and computer skills but must also include supportive aspects ranging from a review of computational arithmetic and statistics to advance problems in application and systems work. Attempts must also be made to familiarize the trainee with the professional behavior and jargon of computer-programmers. While the first two parts of his training are extremely important for maintaining a position and advancement in it, the last part appears to be an important ingredient during placement and acceptance.

Properly trained blind individuals who have been employed have maintained their employment with great success and have advanced in their profession. There may be strong indication that there are many acquired habits a blind person has which make this type of work relatively easy for him and compensate, to some extent, for his lack of vision. There are also good reasons to suspect that a blind person will find a large amount of personal and professional satisfaction in this work.

There is one major problem facing the blind person in this field. His participation in programming depends almost completely on his ability to deal with the computer independently. Because high speed printers and online typewriters can produce output in a form which the blind person can read, the blind programmer can function almost as independently as the sighted one. However, technical development may progress to a point where modification in procedures or modification in printing devices will abolish their ability to emboss braille. From our present experience it would appear that unless some way is found to continue this independent

Letter Request 2/21/68

communication, the employment of blind programmers will cease. Thus one major recommendation of our study would be to conduct continuous research and maintain an awareness of new developments so that problems can be met before they become serious obstacles to the continued employment of blind persons in this field.

Digitized by the Internet Archive
in 2019 with funding from
American Printing House for the Blind, Inc.

https://archive.org/details/trainingofblindf00unse

Table of Contents

(1) Introduction

Visual impairment by itself does not disqualify an individual from the pursuit of practically any occupation and vocation. However the inability of the blind professional to enter fully into the communication network on which so many occupations depend so heavily does effectively bar the access to many sources of employment. Rehabilitation work among blind persons is thus caught on the horns of a dilemma. On one hand the blind individual may have all the necessary intellectual and physical prerequisites to enter a particular profession, including the proper motivation and background. On the other hand his inability to enter into the communication network, to read necessary materials or pursue crucial aspects of his job or to act independently,without substantial assistance, may effectively close the doors of certain occupations to him.

The rapid pace of technology brings with it many by-products. Some of these enter importantly into the world of the handicapped because they may permit the dramatic removal of obstacles which impede the way of full participation in normal activities.

The work on which this report is based is a dramatic demonstration of how technical progress can be used to remove obstacles that impede a particular professional endeavor. It demonstrates not only that blind persons can readily move into a profession once their inability to read necessary materials on the job is removed or circumvented, but also that a fruitful dialogue has to be and indeed can be established among all individuals who participate in the sociological, psychological and technical aspects of such a rehabilitation venture.

(a) Background Information

Programming computers and associated professional work represent today's fastest growing professions. Current estimates count on 60,000 machines in operation by 1970. Yet the mass introduction of computers dates back no more than twelve years prior to this writing. The programming profession arose from the need to make computers do the bidding of a user who had a particular job suitable for machine processing. Since there existed no formal training schools nor were detailed demands of the job known at the time, individuals with appropriate talent and interest were simply drawn into this work from wherever they could be found. At the same time, the requirements on which successful work with computers is based multiplied. As a consequence, the levels and diversity of professional skills required in present programming work encompass a very wide range. Thus, there exists a curious situation in which we have a robust and rapidly expanding profession with only a vague definition, no foolproof criteria for the selection of its participants and

no set methods for their training. In spite of the fact that there are already a number of colleges and universities who purport to give training in computer science, the actual number of organized efforts by which an individual can become involved in computers is relatively small. Even those departments in which so-called "courses in computer science" are offered turn out to be more involved with applied mathematics or numerical analysis than with the training of individuals to deal with some aspects of computer related work. Some formal programming training is offered by commercial ventures that have sprung up like mushrooms all over the country. While some of these schools offer a reasonable exposure to programming concepts, many are little more than rackets. As a consequence, the recruitment and development of programmers is still a fairly haphazard affair.

This situation has many advantages for the handicapped. While on one hand, it is difficult to define the job requirements and training needs, the profession itself is lusty and robust and has a tendency to accept its talents wherever it is found. Thus the fact that an individual is handicapped is in itself not an obstacle for professional acceptance. Thus, handicapped individuals became involved in computer work relatively early. For instance, individuals with motor disturbances were trained as operators and programmers some time ago. However, blind persons were, by and large, excluded from training and working on computers.

There were a number of the usual hindrances preventing the blind person from working with computers. Problems of prerequisites, training facilities, expectation, motivation and even tradition are the common factors which have to be dealt with in opening any new profession. There was, however, one unique aspect of programming that appeared to represent an unassailable obstacle. This was the need for constant rapid communication between the professional programmer and the machine. Programs are submitted to the machine and come back in assembled form with statements concerning errors and other messages (called diagnostics). As programming languages proliferate and become more and more powerful, the amount of such printed material returned to the programmer for study becomes forbidding even for an individual with normal eyesight. There are also a variety of demands for interactive communication between programmer and machine. Some of these involve on-line programming by which the programmer sits in front of the typewriter or console which is directly connected to the computer. The output of the machine in the form of comments on his programming efforts and other messages is either typed for his attention immediately or flashed on a screen before him. Thus programming becomes predominantly an art of "conversing" with a machine. It is a skill in which a special "language" is learned whereby a machine and man can communicate with each other and the execution of a programming job is essentially a conversation between programmer and machine during which a sequence of instructions become properly formulated and checked for their proper execution.

Participation in this exchange of voluminous information between man and machine, is, of course, a major problem for the blind person. There were some attempts to provide blind programming trainees with a reader on the job. However, these failed. As with all technical subjects, the reader must have some knowledge about what to read and where to find it. This means that he himself had to acquire some background in programming. It also means tying down two individuals to do the job of one. Thus, a few blind individuals who had successfully moved into this profession with the help of dedicated and adventuresome coworkers were either quickly shunted into an area of administration, or were retained as technical workers if their contributions to scientific work merited any inconvenience which their use of computers may have imposed on them or their employers. Thus it was clear that unless the bottleneck created by the inability of the blind to communicate with the machine was resolved, this profession would be virtually closed to blind individuals.

The obstacle to effective communication was removed successfully and all at once by the fortuitous discovery that the high speed printer, which is an integral part of the processor complex, lends itself quite easily to the production of text in readable Braille.

The technical aspects of this procedure are quite simple. The computer translates all messages, letter by letter, to their proper Braille equivalents. The Braille symbols themselves are created by having hammers strike with increased force against the paper which has been backed with flexible material (such as a number of layers of paper, garter belt, or even a strip of corn plaster). By using an "*" or a "." an indentation can be produced in the paper which can be read by a blind person as a raised dot. The computer prepared translation is printed in mirror image (or not, depending on the type printer used), thus presenting instant communication of the machine to the programmer in a form which the blind person can read. This method was first described in detail by Sterling,et al in 1964 in "Professional Computer Work for the Blind" (Communications of the ACM, 1964).

The ability to obtain instantaneous communication with a computer provided the blind person with immediate access to the dialogue between man and machine and thus opened the doors of the profession for him.

It was the object of the work reported here to investigate and resolve the remaining technical obstacles facing the blind in programming, to study the best methods to select and train blind individuals for work with computers and to observe conditions under which individuals trained in this way could then be placed in useful employment.

(b) Statement of the Problem

It became apparent very rapidly that while the major obstacle between blind programmers and their profession had been eliminated, a large number of problems still had to be resolved. These were predominantly concerned with the development of additional technical skills needed as programming aids and the support of adequate teaching without using unlimited amounts of costly computer time. Furthermore, it was necessary to find the best ways to teach the blind the pertinent topics, (as well as discovering what some of these pertinent topics are), to define peripheral areas of knowledge and skill which the blind had to acquire for successful job performance and, finally, to gain some insight into the social factors which are involved in successful placing of trained individuals.

1. Technical Aids: Techniques for brailling had to be incorporated within the operating systems and procedures of computing facilities using different machines, thus presenting a large array of different problems. Their satisfactory solution involved systems programming and provision of many software structures which required a high level of professional skill. Since it is unreasonable to expect a new trainee to provide these, preparation had to be made to assess the problems that existed and find solutions for them before blind individuals moved into the working environment. Besides these high level programming problems there were also a number of other necessary technical aids which had to be provided. These included a suitable reader for Hollerith cards, an electronic probe with which a blind person could tell which lights were lit on a computer console or a peripheral device, and of the development of a number of quick methods of taking notes and procedures and techniques for designing and reading flow diagrams.

2. Teaching: Since no ready curriculum outline or organized teaching materials existed for the training of sighted individuals, a curriculum had to be developed for blind trainees, readings made available both in Braille and as audio recordings and teaching efforts established. Teaching programming to a group of students also brings with it a unique requirement that has important consequences. In running a number of programs through a machine, much costly time can be consumed unless a well worked out "batch" system exists which accepts a sequence of programs, assembles or processes them in some way and produces output for all of them without human intervention. Since the class consisted of blind students, all output had to be provided in Braille. Such a system is relatively complex to design and implement and again needs prior solution of a variety of programming problems.

3. Peripheral Skills: Besides mastering programming languages, a programmer must have additional knowledge at his disposal about processors and processing. The necessary elements of such other information, ranging from computational arithmetic to high level software concepts, had to be assembled and put forth in a way that could be taught to the blind trainee. These peripheral skills encompass such diverse items as a knowledge of types of computers, types of peripheral display devices, problems in transmission, special problems of input and output, construction of computer languages and operating systems, multiprocessing, time sharing, mathematical background, statistical background, knowledge of business methods and record keeping, and of many applications.

4. Social Factors: As all other professions, programming has its own customs for finding jobs, doing things on the job and behaving in certain definite ways toward employers and coworkers. In addition, this profession has developed a distinct jargon and an outlook towards the consumer of its services which is unique, perhaps, in its assertiveness. It would be unreasonable to expect blind trainees to fit well into this unaccustomed environment without some preparation. Also, placement itself would be much easier to accomplish if the blind applicant can augment his skills with the outward appearance usually associated with successful programmers. Thus "professionalization" had to be defined and the trainee exposed to professional practices and taught to adopt them.

(c) Review of Relevant Literature

At the time at which this project started, very little if anything was known about programming training for the sighted and practically nothing about the same requirements for the blind. Of utmost importance was a newly printed book by Bauman, M. and Yoder, N., Placing the Blind in Professional Occupations, (Office of Vocational Rehabilitation, Department of Health, Education and Welfare, Washington, D.C.).

Bauman and Yoder had been able to locate three blind individuals who had been trained in programming. The technical needs that had been developed at the time were summarized by Sterling, et al (1964) and represented the summary on technical details known at the time. (However there was not such dearth of information as appears on the surface. The Association for Computing Machinery had appointed a committee of experts which was charged with the specific task of acquiring and assimilating the necessary information. This committee started to work shortly after the onset of this project and results and conclusions of its work were immediately

incorporated into this demonstration effort. The final conclusions of this committee were circulated widely in the report entitled Selection, Training and Placement of Blind Computer Programmers.)

(d) Design of Research

The project was started while the principal investigator was director of the Medical Computing Center at the University of Cincinnati and continued there for two years. During that time the training facility was part of the computing center and the blind trainees had direct access to the computer at almost any time and, more importantly, to individuals who worked with computers. During the last year of the project it was transferred to Washington University at St. Louis, Missouri. Here the training effort was located at the medical college while the computer was located at the main campus, some two miles away. Access to the facilities and to individuals directly involved with programming was more difficult to maintain. However, it was ample for purposes of the project.

The physical space at both locations included generous office space for the students, two lecture rooms and extra rooms for listening to tapes. A secretary was also available for handling personal mail.

(2) Methodology

The investigating staff of the project had acquired some experience in training blind individuals for computer work before the project started officially. Thus, the outline of the training method was based on reasonably well defined criteria of what would or what would not work.

(a) Project Program and Professional Staff

The program of research and demonstration encompassed three relatively separate areas, i.e., selection, training, and placement.

Selection

There are many different types of programming jobs requiring great diversity of background and preparation, so that fixed criteria for selection are difficult to state. However, there are a number of ground rules which might be used to define the minimal skills a person ought to have before training is undertaken with any hope of success:

Education: He or she ought to have a high school degree with two years of high school mathematics and, if possible, a course in high school geometry. Reasonable proficiency in Braille and typing should be part of this background.

Ability: He or she should be adjudged as college material (even if he has not gone to college). The intellectual requirements for an individual acceptable for training might best be summarized by stating that he should be acceptable to a college or university as a degree student.

Motivation: Perhaps it is in the area of motivation where the most important discriminant may be found. Training and job performance make high demands on individual initiative and energies. The individual selected must want to work, having demonstrated his ability to spend long hours at assigned tasks. Also, a desire for independence is very necessary. In general, the fewer blindisms he has and the less the individual is dependent on others to help him, the better will he settle himself into this profession.

Because of the general lack of information about the field (and because of the rampart misinformation) the vocational counselor advising or the blind person selecting this profession should keep in mind that he does not need to have a commanding background in mathematics. He ought to have at least the normal high school complement of two years of algebra. If he has a minimum mathematics background, it is desirable for him to have other skills at his disposal. For instance he should know something about business matters, record keeping, accounting, library work or other topics in which the computer plays an increasingly important role. (Since there are very few fields in which the computer is not rapidly becoming a dominant factor, this acquisition of peripheral skills is really not too difficult to accomplish).

One point that came up repeatedly during selection was a choice between college and programming training. Since the individual who has a minimal requirement ought to have the ability for successful college work, the rule in selection was that such individuals who were young enough to enter college, would be advised to do so rather than to undertake programming training. The reason for this was that while an individual with a minimal background may be trained and become employed in the computer field, his chances for further employment and advancement increases considerably with the amount of college training he has.

The attempt was made in this project to evaluate the suitability of various tests. There are a number of tests that have been used in selecting programmers and, of course, there are a large number of tests which are applicable to the selection of the blind persons for professional work. The project received valuable help from a number of individuals with considerable experience in testing and selecting including Mary Bauman, Douglas McFarland, Robert Dickman, Norman Yoder and others. Various tests were tried and a battery of examinations given to each trainee.

Unfortunately the relevancy of these tests to the selection of programmers is difficult if not impossible to determine. Since almost all individuals selected for training managed not only to complete training but also to obtain gainful employment, test scores seem to be less relevant. This is especially true because the attempt was intentionally made to select individuals with different educational, sex, age, and racial characteristics. Combined with the experience of trying to evaluate tests for programmers (obtained from studies conducted by a special interest group on research in training of computer personnel under the leadership of Dr. Robert Dickman and under the auspices of the Association for Computing Machinery) we would conclude that a testing program for abilities and preferences is probably more futile in selecting programmers than perhaps for any other profession. On the other hand, the important elements appear to be to determine the motivation of an individual. Here, past performance may be extremely important as an adjunct to valid tests of motivation. (It should be emphasized that there was no attempt to select only superior individuals for the program.)

Training

The training program was divided into three categories : viz., technical, supportive, and professional.

Technical: This aspect encompassed the actual programming consisting of training in machine languages, assemblers and compilers. The machine language used was for the IBM 1401, as was the assembly language (SPS). Other languages were for the IBM 7040 and later for the new IBM 360 series. Compilers included COBOL (used mostly for business applications) FORTRAN (used mostly for scientific work) and PL/I (a new language used for both business and scientific work). In addition, some students who were more able than others were given training in more advanced machine language programming on larger computers.

Supportive: Supportive training fell into two areas. One was designed to provide the general background in computer software and hardware which, while not directly necessary for programming training, was the sort of background on which a programmer would build during his employment and which would contribute strongly to his eventual advancement. The second effort attempted to correct for inadequacies in preparation for programming jobs of blind individuals who had not been aiming at a technical vocation.

i. Survey of Systems and Software: Students spent a relatively small but important amount of time in lectures on general background topics in computing. These consisted of a general survey of peripheral devices for input and display of information, transmission of information to and from peripheral devices, description of different types of processors and some knowledge of how they work. Next the students

were introduced to software and systems, concepts and structures of assemblers, compilers as well as of operating systems and their ramifications (such as batch and multi-processing, time sharing and so on).

ii. Mathematics for Calculations: Most students lacked adequate training in computational arithmetic. While high level mathematics is not necessary for programming there is a minimum about arithmetic operations that must be mastered, including the ability to handle fractions and place decimals, common knowledge of number bases, acquaintance with different types of functions, some facility in solutions of simultaneous equations including, if possible, an elementary knowledge of matrix algebra. These were provided in a special class. A few students who had more mathematics than was absolutely necessary spent a small amount of their time studying more advanced topics. This part of the training was dropped during the third year since it really did not add to the ability of the students or to their ultimate employability. All students were given a survey of the most common statistical techniques. For those students who had refresher and supportive work in computational arithmetic, statistics came after they had finished this part of their course (approximately three months). Statistics introduced to give the student better employability and familiarize him with some of the most common data processing demands which would be made on him later on.

iii. Professional: As any other profession, programming has its particular foibles and behavior patterns. An attempt was made during a series of lunch meetings to give the students some appreciation of what the professional demands are on the behavior of the programmer. Also, a number of invited speakers and lecturers were brought in, including successfully employed former students of our program.

Placement

While no organized attempts were made to study different conditions of placement, it was hoped to evaluate different methods by which individuals could be placed if this should prove possible. The methods involved were:

(1) The individual takes his own initiative and tries the channels open to sighted programmers,

(2) Individuals make use of their rehabilitation counselor (ranging from working very closely with the counselor to just using the counselor's leads),

(3) The individual takes advantage of leads provided through members and chapters of the Association for Computing Machinery. However, it was clear from the beginning that each student would, and indeed should, avail himself of all avenues of finding employment.

Project Staff

The project staff had to be relatively large and diverse to carry this program out completely.

Major teaching responsibility for programming was carried by Mrs. Diane Steubing and Mrs. Helen Gigley at Cincinnati and by Mr. John Amick and Mr. David Neblett at St. Louis. Because of the range of languages involved and demands on class time, two instructors were necessary. The mathematics review was taught by the same instructors who handled the higher level languages, with some aid from the other staff in the center. (During the time the project was at Washington University this part was carried out by Mr. Dean Wilbur of MEDCOMP Research Corporation under a contract with that corporation.)

Introduction to hardware and software were the responsibility of Mr. Seymour Pollack and of the principal investigator.

Individual instruction and aids were also furnished by the staff of the computing centers both at Cincinnati and Washington Universities as the need arose. Programmers on the staff kept themselves generally available for consultation during latter parts of the program.

(b) Population and Sample

Individuals were selected for training on the basis of criteria outlined before. Some of the more interesting breakdowns are given in Table 1.

(c) Some Study Factors

The research problem was not so much of fact finding but more in the area of problem solving. A number of obstacles to successful selection, training, placement and on the job performance existed and had to be resolved.

Some of these questions were:

(1) What was the optimal length of the program?

(2) What material ought to be covered in the course, especially, how much and what kind of supportive material?

(3) Were there any special acquired habits the blind person had which were especially useful for programming and that could be exploited during training?

(4) What behavior characteristics if any were especially useful for placement?

Table I

Summary of Students Trained by this Project

Student No.	Age	Sex	State	Education	Type of Placement
1	23	M	Ohio	College	Academic Institution
2	23	M	Missouri	H.S.	Private Industry
3	31	M	Louisiana	College	Private Industry
4	29	M	Ohio	College	Private Industry
5	44	M	Minnesota	College	Private Industry
6	30	M	Minnesota	College	Private Industry
7	27	M	Wyoming	H.S.& some College	Private Industry
8	45	M	Washington, D.C.	College	Government
9	23	M	Ohio	College	Private Industry
10	36	M	Indiana	College	Academic Institution
11	21	F	Ohio	College	Academic Institution
12	37	M	New York	H.S.	Private Industry
13	28	M	New Jersey	College	Private Industry
14	25	M	Washington, D.C.	College	Government
15	30	M	Illinois	College	Academic Institution
16	37	M	Washington, D.C.	College	Government
17	33	M	Washington, D.C.	College	Private Industry
18	29	M	Minnesota	College	Private Industry
19	28	M	Indiana	H.S.& some College	Private Industry
20	17	M	Ohio	H.S.	Private Industry**
21	44	M	Oklahoma	H.S.*	
22	33	M	Kentucky	H.S.	Private Industry
23	35	M	Rhode Island	H.S.	Private Industry
24	33	M	Texas	College	Private Industry
25	28	M	Missouri	H.S.	Academic Institution
26	32	M	Michigan	College	Government
27	28	M	Ohio	H.S.	College Student
28	32	F	Kansas	College	Academic Institution
29	29	M	Virginia	H.S.	Private Industry
30	28	M	Ohio	College	Private Industry
31	30	M	Wisconsin	College	Private Industry
32	23	M	Wisconsin	College	Private Industry
33	23	M	Ohio	College	Unemployed

*Dropped out
**Part Time, still in college

Student No.	Age	Sex	State	Education	Type of Placement
34	36	F	Michigan	H.S.	Government
35	31	M	Michigan	College	Government
36	40	M	New Jersey	H.S.	Private Industry
37	44	M	Michigan	H.S.	Government
38	28	M	Texas	College	Private Industry
39	25	M	Utah	H.S. & College	Private Industry
40	32	M	Michigan	H.S.	Academic Institution
41	21	M	Connecticut	College	Private Industry
42	26	F	Pennsylvania	College*	

*Dropped out

A number of additional questions arose from attempts to solve individual problems such as best methods of incorporating brailling techniques into different operating systems, best methods of writing brailling techniques, hardware problems and so on.

(d) Evaluation of Data

This project did not take the form of data gathering, involving statistical evaluation. No attempts were made to substantiate conclusions by numerical methods although some data do exist which may lend themselves for such purposes.

(3) Results

Table 1 gives the breakdown of the number of individuals admitted and some of their educational and other characteristics.

There were two important results.

Almost all individuals selected for training completed training successfully. Almost all individuals who completed training successfully were placed in profitable employment without too many difficulties.

There were only two individuals accepted for training who did not manage to finish the course. The first was a veteran of the Second World War, an older man who was quite satisfied with receiving his pension and making a go of it. The second was a woman trainee who had a rather severe English problem. (A third person had to interrupt his training for psychotherapy. After a period of intense therapy he went back into training and is now working successfully as a programmer.)

There are only two individuals who are not working at all this time. One of these has sufficient funds of his own to be independent. The second is a completely dependent individual who has shown no initiative at all in seeking placement. Although this individual is skilled enough so that he could be employed, he will obviously not find a job until he makes some attempts to secure a position.

Ease of placement was related to a large extent to independent and aggressive job seeking. In addition, leads were provided through the Association for Computing Machinery and through the personnel of the training facility. (Since large numbers of contacts actually exist between the principal investigators and many computing enterprises, this was rather simple to manage.) Also many leads were provided by rehabilitation counselors.

If the trainee came from a small community he had to plan almost without exception, on resettlement in a larger city.

The number of women trainees in the project was relatively small. Four women were accepted for training of which three finished the course. One of these women was a Negro.

There seemed to have been no relation between initial starting salaries and skill and educational background. Initial salaries ranged from 5,000 to 8,000 dollars per year.

Students by and large preferred industry to government and the majority of graduates now work for private industry. There were a number of individuals with multiple handicaps. These included one person with cerebral palsy and blindness, one person with severe disfigurement and blindness and one individual with almost complete hearing loss as well as blindness. All multiple handicapped individuals are now well employed. However, their training represented additional problems in communication and in supplying aids for participating in the work.

(4) Discussion and Implication of Results

We shall base the final conclusions that can be drawn from this study mostly on our own experience although since we were more than familiar with associated efforts in other training centers, some of these experiences cannot be ignored completely.

It will be very convenient to divide the discussion of results as they reflect on selection, training and placement.

Selection

Perhaps one of the most significant results of our effort has been the demonstration that large differences within individuals accepted for training had very little if any effect on final outcome of training and placement. Trainees differed in a variety of ways. There were large differences in educational backgrounds, ages, locations, and personality. Yet none of these appear to have made a measureable effect on the final outcome of training and placement.

This does not mean, of course, that education, age and the other factors do not make any difference at all. It simply means that there are so many levels of skill in the computing profession so that, with proper training, a variety of different individuals can be trained and placed.

There were also some important commonalities among all individuals. Regardless of differences in background, they were all reasonably intelligent individuals and were highly motivated to enter the training. As a matter of fact the major selection criterion was the individual's desire to be accepted in the program. If this was strong enough, other deficiencies could often be waived or overlooked. The high level of motivation was perhaps one of the most necessary components since the training period itself may be described best and with some reliability as "rugged", making immense demands on the trainees' time and efforts.

Hence, our final conclusion concerning selection of blind individuals for training as programmers, is that the profession is varied enough to accommodate a large range of different individuals. Tests scores, whether of special aptitude or personality, may not be too relevant. Educational background ought to be at least of some minimum such as a high school degree with some mathematics but it is <u>important</u> to keep in mind that neither a college degree nor facility in mathematics are prerequisites. In fact few if any of our trainees had either. Age does not appear to be a limiting factor at this time. It might be very useful in the future to examine the possibility of providing such training for older individuals who have had a successful work history in clerical or semi-professional capacities.

In summary, the basic requirements for programming opportunities appear to be strong motivation to do work and work hard, a fierce desire to be independent and of reasonably normal intelligence.

<u>Training</u>

Requirements for training may be divided into three components: technical training, supportive training, and professionalization. It is true that each one of these efforts demand vastly different amounts of time, differences in effort, and perhaps even differences in training personnel. However at this time it is difficult to say which of the three components is by itself more important than the others.

Technical competence, of course, is the basis on which hinges advancement in employment and future development of the employee. The individual must be facile in a number of artificial languages so he can switch from one to another. He must also have a basic grasp of some of the fundamental concepts in the computer fields. He must have a rudimentary understanding of the structure and purpose of assemblers and compilers as well as operating systems. He must know the different types of operating systems that exist, and the trends in future developments. With it he has to have minimum knowledge of the type of processors that are available and peripheral devices which may serve as input and output media. This phase of his training accounts for most of his time (roughly 75%) and probably for almost 90% of the cost of training. It is important that the trainee have access to computers,

that he has a good brailling system available so that he himself can search out errors in his own work and be independently responsible for his problems, that he have ready access to a discriminating group of teachers who will not do the work for him but help him when a normal problem arises for which additional information is needed. The teaching staff to fulfill this part of the training has to be well versed not only in computer languages (and how to teach them) but also in software and hardware concepts.

The amount and kind of corrective and supportive training needed will depend to a large extent on the student's background. If a student has a college degree and a grasp of mathematics, logical algorithems, as well as record keeping and other skills, then a great deal of supportive training can be obviated. However, most blind individuals are not sufficiently prepared, even in rudimentary arithmetic. It is difficult to see how a training effort could succeed without giving the student a strong review in computational arithmetic. Roughly 20% of the students' time was spent in this endeavor. The time used on this effort was not constant through the training course. During the first three months, the student spent almost half his time on mathematics review, layout of records, and associated topics. The fact that in our training this review was followed with a survey of statistical practices may be considered as icing rather than a requisite. Those students who had an adequate background in those areas which were touched by supportive training spent this time on programming without harmful consequences either to their completion of training or subsequent placement. Thus there is no need to subject all students to the same program. While supportive training should be provided, the student should be introduced to it only if deemed necessary.

Perhaps the least palpable of the training topics is that of professionalization. Part of professionalization is of course a knowledge of what goes on in the field. Seminars were thus held to describe applications in a wide variety of areas including business, industry, manufacturing, and science. Speakers were brought in from the outside as well as from local sources. As a consequence the student was provided with a matrix of background information which permitted him to speak more knowledgeably about the sort of things being done in the field which he was about to enter.

However this type of background information does not tell the complete story. Successful professionals have certain characteristics which the student has to acquire.

One of the characteristics of programmers is an intense and purposeful expenditure of effort. This is probably one of the main ingredients of successful professional work in all fields but perhaps one of the most commonly found in programmers. On the other hand the blind students come, basically, from a background in which such purposeful and busy efforts were seldom required of them. The introduction of long hours during the training session served to bridge the gap between relative inactivity in the student's background and hyperactivity required of the working programmer. The student not only spent eight to nine hours in laboratory and class but large demands were made on his time outside class to finish his work and

tackle new projects. The student was put under continuous pressure to produce good results and answers to assignments as quickly as he could. In fact he was given three or four problems to program at the same time. Students were given to understand that they were entering a field in which a seven day week and ten hour work day might be normal. They were given free access to the training facility and the computer and the responsibility to see for themselves that their work would progress smoothly.

There was no question but that the student suffered somewhat in the beginning under this pressure. However, after the first three months of training had passed, it was not necessary to press the students further. By that time the motivation to push the work along became largely self-generated. At the end of the training, the student was taking quite obvious pride in his ability to do more than a day's work.

In this connection it is interesting to note that none of the reports and informal feedbacks received from employers in any way indicated that the trainee is working exceptionally hard. This does not mean that he does not. It shows that he has adopted the general work patterns of the profession so that this part of the training may be a very necessary component.

The least teachable aspect of professional behavior is the certain demeanor, normal aggressiveness and associated reactions shared by members of a profession and certainly very markedly by members of the computer programmer groups. A number of attempts were made to inculcate useful techniques of dealing with other programmers and some knowledge about the social problems the student was facing. He was taught the "language" with which programmers converse in an off-handed way among themselves. This was done by introducing this sort of language during regular lunch periods, bringing in programmers for light conversation whenever possible and establishing a social interaction between students and programmers at the center. A strong effort was made to introduce the "jargon" of computing and to make sure that the trainee used that jargon.

An open and frank discussion of sociological professional problems were also attempted. The student seemed to realize quickly that it would pay him to keep on his toes in dealing with other programmers, that it was important to attend professional meetings and especially important to participate in social activities among programmers in the center or during meetings of the local chapter of the Association for Computing Machinery.

Placement

It is noteworthy that most students placed themselves during the first and second job interview. This success is difficult to ascribe to technical competence alone. It is impossible, during the employment interview, to assess a person's technical competence to such a degree that one can

overcome the usual inhibitions and prejudices toward the hiring of blind individuals. We are strongly convinced that the greatest selling point during placement was not so much the technical grasp which the trainee had but his behavior which suggested the "successful programmer". We do not think, therefore, that the importance of professionalization can be stressed sufficiently.

The major implication of experience in placement appears to be that an individual who was properly trained, motivated, uses the language of programmers and behaves very much like one will have very little difficulty in finding a job if he has the initiative to go out and look for one.

However it would be foolish not to teach the programmer to take advantage of other services especially of those offered through his rehabilitation counselor.

Perhaps one of the most powerful and useful ways to develop job leads were through the staff (especially through the senior staff) of the computing center. Thus both programmer and counselor can use the professional organizations to which the blind programmer ought to belong to develop useful contacts.

Vocational rehabilitation counselors were able to develop a relatively large number of leads for most of their clients. Leads are of course very helpful, although it is probably true that the vocational rehabilitation counselor who does not know too much about the profession can also do his clients a certain amount of harm.

One of the most important steps in placement and potentially the largest obstacle in the way to employment is the immediate supervisor. It is not true that setting of policy at top administration levels will necessarily lead to employment of blind programmers. We have had instances where, despite formal administrative policies promulgated by presidents and vice presidents of firms, we were unable to place properly qualified blind individuals in programming jobs. The dynamics of the situation hinged around the immediate supervisor.

The immediate supervisor has a limited budget and a job to do with it. Good programmers are hard to come by and he will be very reluctant to place his money on an individual whose background and ability to function in the computing environment he will doubt. Supervisors of programming groups are usually capable individuals who need not necessarily have any appreciable amount of education and very seldom have motivation other than to succeed on the job and progress in the company. Thus they will look unfavorably on having added to their group and responsibility an individual who cannot "pull his load".

Since good programmers and especially good supervisors of programming groups are terribly difficult to come by, any promulgated company policy concerning the hiring of blind or handicapped individuals will simply be ignored by the management if the supervisor of a programming group will

not go along with it. In most instances management will not question the judgment of the supervisor in this matter and there is really no way in which company policy can be enforced unless the programming supervisor goes along with it.

This means, of course, that avowed intention at top administrative level is not needed to place blind computer programmers. If a supervisor is convinced that a blind person is an ideal employee for him he will hire such a person without informing himself particularly as to what company policy in this matter might be.

(We have had instances in which an individual negotiated for a job with a supervisor and employment was later refused by upper levels of company management because the hiring of blind individuals was against policy. We have no way of knowing, of course, where such a company policy existed but were ignored because the employee had been selected by the crucial supervisor of the programming group.)

Thus, it is clear that the interview between the blind programmer and his immediate potential supervisor are the most important placement events. If he can convince the supervisor that he is a good programmer, technically competent, sufficiently independent and able to fit into the group, employment is usually immediate. On the other hand his inability to act like a programmer or to answer specific questions about the job will make him unemployable. For this reason it is also dangerous to have the placement counselor converse in too much details about job performance with a supervisor. Since the placement counselor himself usually is not skilled in programming and unaware of many highly technical aspects of the field, he may inadvertently answer a question of concern to the supervisor in such a way that the latter will decide against hiring a blind programmer. It is for this reason that a properly trained candidate ought to seek an interview by himself and it is also inadvisable for the rehabilitation counselor to be present during the job interview.

Success of Blind Programmers

There is one aspect of our results which has not been discussed in detail and appears to be difficult to come to grips with substantively. Of the large proportion of our trainees which have become employed, few have moved to other jobs. I know of only one instance where an employer has expressed open dissatisfaction with his choice. Quite to the contrary, there are many instances in which employers have either requested a second blind employee from our program or have in some other way indicated their extreme satisfaction with the performance of the individual and his ability to do the job.

This finding ought to be unexpected since by and large the blind trainee came to this profession with a background which hardly suited him

for computer work. In fact, in many instances the blind trainee would not have been advised or even permitted to go into programming had he been sighted.

This rather unusual circumstance gives rise to the suspicion that perhaps the blind person may have special characteristics, acquired as a consequence of his blindness, which also help him to become very successful in working with computers.

There do indeed seem to be such characteristics, all of them in the form of acquired habits and tendencies, which appear to be extremely useful. There is no way of telling which of these habits or attitudes may be more important than others. We shall just point to some of them.

Programming is intellectually very stimulating. It consists of solving of problems on various levels. There are also many rewards and reinforcements for having used the correct strategy to solve a problem, be it small or large. It has not been unusual for individuals who started to program to give up other sources of entertainment (such as bridge or chess). Thus programming is not only an occupation but also a vocation and source of entertainment. The blind programmer may become perhaps more involved with his work than his sighted counterpart because the obstacles for successful completion of programs become in themselves interesting problems which he solves in his leisure time.

Quite independent of the avocational aspects, there are a number of features to successful programming which depend very much on a well organized memory and well organized spatial orientation. A blind candidate who can qualify for and complete programmer training successfully probably has large measures of both.

There is finally the self-selective aspect of this profession. Before a blind person can even inquire about programming training he must have mastered many peripheral skills. He must be of a relatively independent attitude and highly motivated. He must also be of at least average intelligence and have learned how to use whatever intellectual gifts he possesses to his best advantage. Thus there is a constant process that selects out individuals who may not be properly suitable for this type of training. As a consequence, those who finally are selected because their background appears to lend itself to programming (although sometimes only by using a good bit of imagination) tend to do well.

Thus the rehabilitation worker need not be overly concerned with the actual suitability of a blind person for this field. If his client is reasonably motivated and can be fit into programming by some stretch of the imagination and if he can successfully apply for training then the chances are excellent that he will do well in this field.

(5) Summary

Work as computer programmers appears to be a profitable field for blind individuals of all ages and abilities and with practically all educational background.

The major requirement for the field appears to be motivation and a reasonably normal intelligence as well as a strong desire to be independent. Actual educational background is probably of secondary importance as are various ability test scores.

Most individuals who are selected (on the basis of these criteria) tend to finish a program of training and subsequently become successfully employed.

The rehabilitation worker should be very much concerned with the ability of a training center to provide his client with adequate training. Training should not be limited to computer programming and computer skills but must also include supportive aspects ranging from a review of computational arithmetic and statistics to advanced problems in applications and systems work.

Attempts must also be made to familiarize the trainee with the professional behavior and jargon of computer programmers. While the first two parts of his training are extremely important for maintaining a position and advancement in it, the last part appears to be an important ingredient during placement and acceptance.

Properly trained blind individuals who have been employed have maintained their employment with great success and have advanced in their profession. There may be strong indication that there are many acquired habits a blind person has which make this type of work relatively easy for him and compensate, to some extent, for his lack of vision. There are also good reasons to suspect that a blind person will find a large amount of personal and professional satisfaction in this work.

There is one major problem facing the blind person in this field. His participation in programming depends almost completely on his ability to deal with the computer independently. Because high speed printers and online typewriters can produce output in a form which the blind person can read, the blind programmer can function almost as independently as the sighted one. However, technical development may progress to a point where modification in procedures or modification in printing devices will abolish their ability to emboss Braille. From our present experience it would appear that unless some way is found to continue this independent communication, the employment of blind programmers will cease. Thus one major recommendation of our study would be to conduct continuous research and maintain an awareness of new developments so that problems can be met before they become serious obstacles to the continued employment of blind persons in this field.

(6) References of Relevant Articles Published on the basis of the Work Reported Here

1. Sterling, T. D., Lichstein, M., Scarpino, F., Steubing, D., Steubing, W., Professional Computer Work for the Blind, Comm. of the ACM, 7, 1964.

2. Sterling, T. D., Lichstein, M., Scarpino, F., Steubing, D., Steubing, W., "Computer Work for the Blind." Journal of Rehabilitation, 1964.

3. Sterling, T. D., Landwehr, J. B., McLaughlin, C., Pollack, S. V., "The Role of the Blind in Data Processing." Proc. of the Third Annual Conference on Computer Personnel Research Group held at Washington University, 1965. (in press) and reprinted in Computers and Automation, 1966.

4. Sterling, T. D. and Bauman, M. K., "Employment Potential for the Blind in Computer Related Fields", Int. Journal for the Education of the Blind, 1965.

5. Landwehr, J. B., McLaughlin, C., Mueller, H., Lichstein, M., and Pollack, S. V., "BLNSYS - A 1401 Operating System with Braille Capabilities." Comm. of the ACM, 8, 1965.

6. Sterling, T. D., Sekola, P., Steubing, Diane, Careers for the Blind in Electronic Data Processing, Occupational Outlook Quarterly, 9, 1965.

7. Sterling, T. D., The Blind As Computer Programmers, Rehabilitation Record, 1966.

8. Sterling, T. D., A New Direction in Rehabilitation Through Advanced Instrumentation and Computation, Journal of the American Medical Association, 7, 1967.

HV1711
W279
c.2

Washington University

TRAINING OF THE BLIND FOR PROFESSIONAL COMPUTER WORK.

Date Due			
~~6/24/97~~			
~~5/15/98~~			

Bro-Dart
INDUSTRIES
Newark • Los Angeles
Brantford, Ontario
made in usa